RESEARCH INFORMATION BULLETIN

A series of reports by the Naval Medical Research Unit - Dayton

No. 12 - 47 Date: 6 July 2012

Objective Assessment of Student Naval Flight Officer Fatigue during Primary Flight Training

Fatigue continues to pose a serious threat to the health, safety, and operational effectiveness of military aircrew. Recent efforts to mitigate the effects of fatigue have focused on the identification of individualized "readiness-to-fly" screening measures. Eye-tracking measures, such as saccadic velocity in a simple visual tracking task, have shown promise in the laboratory setting for their ability to detect and quantify fatigue-related performance decrements in a military aviation population subjected to sleep restriction. Despite their effectiveness under controlled laboratory conditions, it is uncertain whether such measures are sensitive enough to detect subtle variations in fatigue resulting from nightly variability in sleep quantity.

The purpose of this study was to assess the relationship between naturally varying sleep quantity and eye-tracking measures of fatigue in an operational setting. Thirty-one Student Naval Flight Officers (SNFOs) (average age = 24.1 years [SD = 2.06]) from Training Air Wing 6 at NAS Pensacola participated. The study protocol was approved by the Naval Aerospace Medical Research Laboratory Institutional Review Board in compliance with all applicable Federal regulations governing the protection of human subjects. No specific groups were excluded from participation in this study.

Subjects were recruited during a student orientation meeting in squadron spaces. After informed consent was obtained, subjects were outfitted with a wrist-worn actimeter to track sleep and completed baseline testing with a stand-alone eye-scanning system. Subjects were then released with instructions to complete one eye scan immediately prior to each training flight, and as often as possible during academic training. Data from the actimeters were downloaded at the TRAWING approximately every 28 days. Subjects participated over the course of 9 – 12 weeks, depending on individual training schedules and progress. After a maximum of 12 weeks subjects returned the actimeters and were debriefed.

Pupil diameter, constriction latency, response amplitude, and saccadic velocity were tracked using the PMI FIT® 2000 (PMI), which uses eye-tracking and pupil response to identify impaired physiological states due to fatigue. Baseline was established by the average of 10 trials taken during non-impaired conditions. Each trial required approximately 30 seconds.

Nightly sleep was tracked using the Motionlogger® Micro Sleep Watch, which is a water-resistant, wrist-worn actimeter that measures subject sleep patterns with a high degree of accuracy. Subjects were outfitted with the actimeter on the day of recruitment. Subjects were instructed to wear the watch for the duration of the study (9 – 12 weeks), only taking it off at the 28 and 56 day marks during which data were transferred to the master database.

The relationship between naturally occurring sleep and saccadic velocity was determined using correlational analyses. Patterns of sleep variability were visually inspected, and it was noted that intra-subject variability differed considerably from subject to subject. To characterize this pattern, intra-individual standard error of the average time slept the night before each eye scan was used to group subjects into high, medium, and low sleep variability subsets. Pearson's product-moment correlations were calculated for the entire sample (Figure 1) and then for each sleep variability group separately (Figure 2).

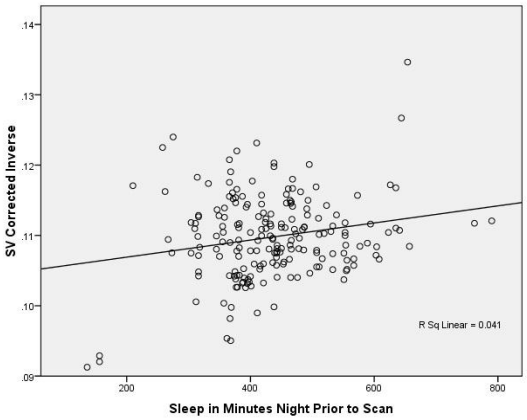

Figure 1. Sleep and Saccadic Velocity Correlated at Group Level

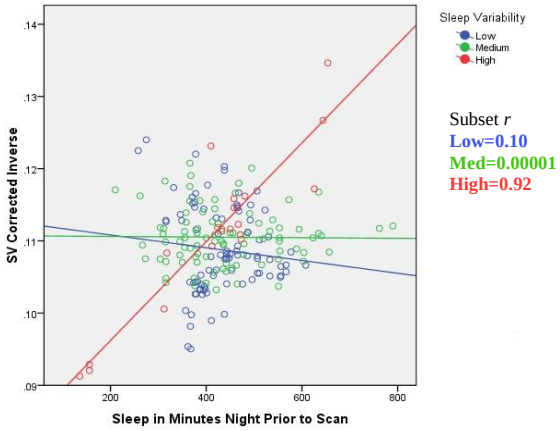

Figure 2. Sleep and Saccadic Velocity by Sleep Variability Subset

There was a significant positive correlation between minutes slept the night prior to an eye scan and saccadic velocity the next day, r (197) = .20, p <.01, on the group-level (Figure 1). When the correlation was plotted according to sleep variability, the high variability subset emerged as largely responsible for the group-level relationship (Figure 2). The subset pattern indicates that saccadic velocity is sensitive to naturally occurring patterns in nightly sleep, but only when there is significant variability in the amount of sleep achieved over the course of several nights.

These preliminary results suggest that eye-tracking measures sensitive to fatigue in the laboratory may also be sensitive to naturally occurring patterns of fatigue in an actual training context. Variable compliance with study requirements and subsequent attrition bias may have produced range restriction in sleep quantity and eye-tracking measures. Thus, these results may underestimate a larger true effect. Subjects who exhibited high variability in nightly sleep also tended to drop out of the study before completion (5 subjects fit this pattern). Causal factors for variability of nightly sleep are not known, though previous laboratory results suggest stable individual differences in fatigue susceptibility may be implicated. Further research is necessary to identify these factors and provide context for further interpretation of the current results.

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 This work was funded by work numbers 70803. The study protocol was approved by the Naval Aerospace Medical Research Laboratory Institutional Review Board in compliance with all applicable Federal regulations governing the protection of human subjects.

REPORT DOCUMENTATION PAGE

1. REPORT DATE (DD MM YY)
06 07 12

2. REPORT TYPE
Research Information Bulletin

3. DATES COVERED (from – to)
Oct 2010 – Dec 2011

4. TITLE
Objective Assessment of Student Naval Flight Officer Fatigue during Primary Flight Training

5a. Contract Number:
5b. Grant Number:
5c. Program Element Number:
5d. Project Number:
5e. Task Number:
5f. Work Unit Number: 70803

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8. PERFORMING ORGANIZATION REPORT NUMBER
Report No. NAMRU-D-12-47

8. SPONSORING/MONITORING AGENCY NAMES(S) AND ADDRESS(ES)
Office of Naval Research, Code 34
One Liberty Center
875 N Randolph St., Ste. 1425
Arlington, VA 22203-1995

10. SPONSOR/MONITOR'S ACRONYM(S)
ONR Code 34

11. SPONSOR/MONITOR'S REPORT NUMBER(s)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

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15. SUBJECT TERMS
fatigue, sleep, eye-tracking, PMI FIT 2000, actigraphy

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	18a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Commanding Officer
UNCL	UNCL	UNCL	UNCL	3	18b. TELEPHONE NUMBER (INCLUDING AREA CODE) COMM/DSN: 937-938-3872 (DSN: 798)